The Basic Biology of *Juniperus* Seed Production

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Johnson, G. 1995. The Basic Biology of Juniperus Seed Production. In: Landis, T.D.; Cregg, B., tech. coords. National Proceedings, Forest and Conservation Nursery Associations. Gen. Tech. Rep. PNW-GTR-365. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 44-46. Available at: http://www.fcnanet.org/proceedings/1995/johnson.pdf

Abstract-Junipers produce dormant seed in response to dispersal by animals and environmental conditions.

INTRODUCTION

Junipers are important species in windbreaks, wildlife, environmental and landscape plantings throughout the Great Plains and elsewhere. Dense, evergreen foliage blocks the wind year round and provides wildlife habitat. The berry-like cones are eaten and dispersed by birds and other animals. Junipers are also drought, heat and cold tolerant.

Seed dormancy hinders nursery seedling production. Often, many of the viable seed do not germinate. Understanding the basic biology of the seed production will help to find better ways to overcome seed dormancy. More work needs to be done to understand the dormancy mechanisms.

NATURAL LIFE CYCLE OF JUNIPERS

Unlike pines and most other trees, jumpers are either male or female (dioecious). Seed is produced on the female trees only. Pollen from the male trees lands on a water drop at the micropyle opening and is drawn into the pollen chamber as the drop shrinks. The pollen germinates and fertilizes the egg.

Lack of pollination is not the cause of empty seed, because seed will not form unless pollen is present. One possibility for empty seed could be a lack of compatibility after fertilization. Another possibility could be lack of fertilization. The presence of the pollen could be enough to initiate cone and seed formation

In most Junipers, including eastern redcedar, Juniperus Virginians L., the berry-like cones are produced in one growing season. Two growing seasons, however, are needed for cone production in Rocky Mountain jumper, Juniperus scopulorum Same. Birds and other animals eat the cones; the seed pass through the digestive system (chemical scarification), then sit in a warm wet pile of decomposing organic matter in the late summer and fall. After passing the winter frozen, perhaps thawing several times, the seed germinates in the spring, or remains dormant through another yearly cycle and germinates the second spring. Seed dormancy is required to prevent early germination.

SEED DORMANCY
Our challenge is to understand the dormancy mechanisms and to overcome them to produce seedlings. Junipers have both seed coat and chemical dormancy. The seed coat is semipermeable and the embryos need a period of time -called after-ripening - to produce all the chemicals in the right balance to germinate.

One of several possible models for the chemical part of juniper dormancy is Kahn's "hormone interaction model" where various amounts of gibberellic acid, cytokinins, and an inhibitor interact to promote or inhibit germination. In Kahn's model, gibberellic acid promotes germination in some seed, but if an inhibitor is present, then a cytokinin must be present to neutralize the inhibitor.

Chemical processes within the seed are dependent on many factors, including temperature and time. Some temperature regimes, such as cold stratification, favor the production of chemicals promoting germination. Time is needed for the chemicals to increase to the threshold amount needed for germination, or for the inhibiting chemicals to be neutralized.

The hormonal balance may be shifted by adding hormones to the seed by soaking the seed in a hormone solution, but the semi-permeable seed coat inhibits the uptake of the hormones. Leaching the inhibitor from the seed by putting the seed in running water for several days may also reduce dormancy in some seed, but again, the semipermeable seed coat may impede the process. Soaking the seed in lye, as done at several nurseries, may make the seed coat more permeable (simulating a bird's digestive tract).

FACTORS AFFECTING SEED DORMANCY
1) Freshness and ripeness of the seed: The time of collection and length and conditions of storage affect the degree of dormancy. Fresh, ripe seed are not as dormant as unripe seed or seed stored for a long time.

2) Environmental factors during formation of the cone and seed: Climate or weather conditions during the growing and maturation of the cone and seed, such as drought, can affect dormancy.

3) Variations in genotype:

Eastern redcedar and Rocky Mountain juniper have wide geographic ranges and great genetic variability. Without this genetic variability, the species probably could not grow over such a wide area. Local populations have adapted to local conditions.

Genetic variation exists within local populations A factor increasing this local variability is that both eastern redcedar and Rocky Mountain juniper hybridize with other junipers and with each other. The variations in genotype within the local populations and across the geographic ranges contributes to the variations in dormancy.

4) Random variation:
Seed produced by the same parents under the same circumstances of environment, time, and place exhibit variations in dormancy. This random variation in the degree of dormancy ensures that all the seed do not germinate at the same time. Spreading the germination over time increases the probability that some seed will germinate during favorable conditions for seedling establishment. We should not expect all seed produced by a tree in a given season to have the same degree of dormancy.

SINGULARIZATION

Due to flower morphology, approximately two thirds of eastern redcedar cones produce one seed, about one third produce two seeds, and about two percent produce three seeds. Often, seed from the same cone are bonded tightly together. In laboratory testing, the seed are separated, or singularized, before the tests are run. If a nursery manager plants non-singularized seed using seed per pound and germination or tetrazoliurn data from singularized seed, the result will not meet expectations. Depending on the number of double and triple seed in the lot, the difference could be as much as one third greater in germination, or one third less in seeds per pound. For example, if one hundred singularized seeds germinate 80% in the testing laboratory, and the nursery manager plants one hundred non-singularized seeds with 33 double seeds (133 seeds total), then 106 seedlings will germinate in the nursery. In the same lot, 51,700 seeds per pound of singularized seed would be equivalent to 38,800 seeds per pound of nonsingularized seed.

Seed testers and nursery managers need to agree on the basic question: what is a seed? Otherwise, seed testing results are not representative of the lot as the nursery manager sees the seed. Unless the nursery manager knows the percentage of double seed in the lot and compensates accordingly, the germination and seeds per pound data could be misleading.

The National Tree Seed Laboratory reports the number of double and triple seed present in the sample. The nursery manager can use this information to adjust seeds per pound and germination expectations.

Germination adjustments: (100 + % of doubles) x laboratory germination % non singularized germination percentage

Seeds per pound adjustments: 100 / (100 + % of doubles) x laboratory seeds per pound non singularized seeds per pound

CONCLUSIONS

1) More work needs to be done to better define the dormancy mechanisms and to develop methods for nurserymen to break seed dormancy

2) Due to variation in dormancy within a lot, methods developed to break the dormancy of the more dormant seed can be expected to be harsher or greater than needed or tolerated by the less dormant seed. Many less dormant seed

may not survive the dormancy breaking treatment for the more dormant seed.

3) Seed testing laboratories and nursery managers need to work together and develop seed unit definitions for Juniperus consistent with use in the nurseries.

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